FINAL REPORT

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Report Covering the Period:	9/01/87 - 1/31/96
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Final Report (NAG5-985) covering 9/1/87 - 1/31/96.
"Ultraviolet Observations of Selected Astronomical Sources"
Alexander Brown, P.I. (University of Colorado)

This NASA grant covered my IUE observing and data analysis programs, which are listed below. This grant included the following IUE research areas and GO programs :-

i) Atmospheric Structure And Variability of Hybrid-Chromosphere Stars

High Dispersion Study of Coronal K Bright Giants (CSJAB)

Long-Term Mg II Variability of Hybrid-Chromosphere Stars (CCMAB)

Long-Term Mg II Variability of Hybrid-Chromosphere Stars (CCNAB)

Long-Term Mg II Variability of Hybrid- Chromosphere Stars (CCOAB)

Seven hybrid-chromosphere stars were observed systematically for 7 years to investigate the chromospheric variability of these evolved cool stars. Using these spectra plus additional archive data we studied the variations in the Mg II 2800Å emission lines over the period 1978-93. Significant nonperiodic variability at the 20-40% level was detected but the periodic variations reported by others were shown to be false. Dramatic changes in the emission line profiles were seen occasionally. The observed variability is consistent with stochastic changes associated with the slow growth and decay of active regions and the gradual evolution of conditions within the stellar winds. Results were published in Brown, Deeney, Ayres, Veale, & Bennett (1996). Data from these programs were also used by Brown, Drake, Van Steenberg, & Linsky (1991) in their coronal study of these stars. The techniques developed for this research were used in additional studies, e.g. Cuntz et al. (1996).

A Magnitude-limited Survey of Single Non-variable G Supergiants (GSNAB)

Completion of A Magnitude-limited Survey of Single Non-variable G Supergiants (MLOAB)

Results from these programs are described by Deeney, Brown, & Ayres (1996).

ii) Flaring And Variability of RS CVn Binaries and Flare Stars

Simultaneous Multiwavelength Study of The Young Rapidly-Rotating K Dwarf "Speedy Mic" (SMOAB)

Origin of Hydrogen Balmer Emission From Stellar Flares on M Dwarfs (HBOAB)

No flares were detected.

Simultaneous Coronal, Transition Region, and Chromospheric Spectroscopy and Atmospheric Modelling of the RS CVn Binary HR1099 (RSPAB)
Simultaneous Coronal, TR, and Chromospheric Spectroscopy of HR1099 (RSQAB)

Dramatic flaring was detected in both 1993 and 1994. These observations were obtained simultaneously with EUVE spectroscopy and VLA/AT radio monitoring and allowed detailed study of coronal and transition region flaring within the HR1099 system. Results are presented in Brown (1996), Brown, Skinner, Stewart, & Jones (1996), and Dempsey et al. (1996).

Simultaneous Ultraviolet and Radio Variability Study of the 4 Draconis System (MGJAB)

IUE data of this system were used by Reimers, Griffin, & Brown (1988).

iii) UV Emission Lines And Variability of Pre-Main Sequence Stars
Continued UV Monitoring of the Pre-Main Sequence Star RY Tauri (TTJAB)
Chromospheric/Transition Region Variability Processes and Atmospheric Inhomogeneity on T Tauri Stars (TTKAB)

Earlier IUE processing of these spectra severely limited variability studies of the high temperature UV lines due to the weakness of T Tauri star spectra. Further analysis is now proceeding using the significantly improved spectra in the IUE Final Archive.

Chromospheric and Transition Region Structure of Intermediate Mass Pre-Main Sequence Stars (CCJAB)
High-Resolution IUE Observations of HD104237 (HAMAB)

Spectra from these programs led to more detailed HST/GHRS observations that revealed the influence of a disk wind, produced by interaction between the stellar and disk magnetic fields, on the UV emission line profiles (Brown et al., 1997).

iv) Absorption Line Spectroscopy of Eclipsing Binary Stars
Eclipse Mapping of the Chromospheric and Transition Region Structure of the Hybrid-Chromosphere Star HR2554 (G6 II) (ZAQAAB)

The IUE spectra were used to establish the time of mid-eclipse for the 1994 April eclipse of this binary (April 18.16) and are still being analyzed in conjunction with HST/GHRS spectra of the April 1994 and May 1995 eclipses.

Papers Published Or Supported by This Grant

Brown, A. 1996, "Cool Stars in the EUV: Spectral and Structural Variability", IAU Colloquium 152, "Astrophysics in the Extreme Ultraviolet", Eds. B. Haisch & S. Bowyer, (Cambridge University Press: Cambridge), p. 89.

Brown, A., Deeney, B.D., Ayres, T.R., Veale, A., & Bennett, P.D. 1996, "Mg II Emission from Hybrid-Chromosphere Stars: 1.5 Decades of Chromospheric Variability Monitoring", *Astrophys. J. Suppl.* **107**, 263

Brown, A., Drake, S.D., Van Steenberg, M.E., & Linsky, J.L. 1991, "X-ray Emission From Hybrid-Chromosphere Stars", *Astrophys. J.* **373**, 614

Brown, A., Skinner, S.L., Stewart, R.T., & Jones, K.L. 1996, "Simultaneous X-Ray, EUV, UV, and Radio Observations of the Corona of the RS CVn Binary HR1099", in *Magnetodynamic Phenomena in the Solar Atmosphere - Prototypes of Stellar Magnetic Activity*, Eds. Y. Uchida, T. Kosugi, & H.S. Hudson, IAU Coll. 153, (Dordrecht: Kluwer), p. 279.

Brown, A., Tjin A Djie, H.R.E., Blondel, P., Harper, G.M., Bennett, P.D., & Skinner, S.L. 1997, "HST GHRS Observations of the Herbig Ae Star HD104237: First UV Observations of a Hot Disk Wind from a Pre-Main Sequence Star", in *Accretion Phenomena and Related Outflows*, Eds. D.T. Wickramasinghe, L. Ferrario, & G.V. Bicknell, IAU Coll. 163, ASP Conf. Ser. xx, in press.

Cuntz, M., Deeney, B.D., Brown, A., & Stencel, R.E. 1996, "Short-term Chromospheric Variability in α Tauri (K5 III): Results from IUE Time Series Observations", *Astrophys. J.* **464**, 426

Deeney, B.D., Brown, A., & Ayres, T.R. 1996, "Outer Atmospheric Structures of High Luminosity G/K Stars", in *Cool Stars, Stellar Systems, and The Sun: 9th Cambridge Workshop*, Eds. R. Pallavicini & A.K. Dupree, ASP Conf. Ser. xx, in press.

Dempsey, R.C. Neff, J.E., Thorpe, M.J., Linsky, J.L., Brown, A., Cutispoto, G., & Rodono, M. 1996, "Goddard High Resolution Spectrograph Observations of Variability in the RS CVn System V711 Tau (HR1099)", *Astrophys. J.* **470**, 1172.

Reimers, D., Griffin, R., & Brown, A. 1988, "4 Dra – A Unique Triple System Containing an M3 III Giant (SB Period 1703 d) and a Cataclysmic Binary (P = 3^h59^m)", *Astron. Astrophys.* **193**, 180

Stern, R.A., Uchida, Y., Walter, F., Vilhu, O., Hannikainen, D., Brown, A., Veale, A., and Haisch, B.M. 1992, "Coordinated Ginga, IUE, and VLA Observations of Stellar Activity in σ^2 CrB", *Astrophys. J.* **391**, 760

Vealé, A. & Brown, A. 1990, "Long-Term Variability and Activity Cycles in Hybrid-Chromosphere Stars", in *Cool Stars, Stellar Systems, & The Sun*, Ed. G. Wallerstein, ASP Conf. Ser. No. 9, p. 145.